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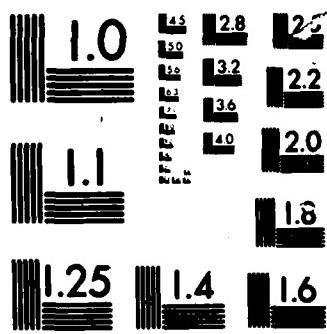
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United States General Accounting Office

**Report to the Honorable
Lowell P. Weicker, Jr.
United States Senate**

May 1986

WEAPON SYSTEMS

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Issues Concerning the Army's Light Helicopter Family Program



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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division
B-222896

May 22, 1986

The Honorable Lowell P. Weicker, Jr.
United States Senate

Dear Senator Weicker:

As you requested, we have reviewed the Army's Light Helicopter Family (LHX) program. Our review covered the following areas: acquisition costs, affordability, operation and support costs, requirements, technical risks, acquisition strategy, and program alternatives.

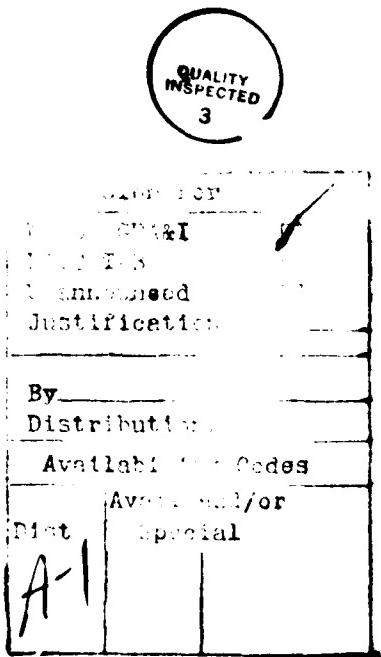
The program's goals are worthy—replacing some of the Army's aging helicopter fleet with aircraft which, among other things, would outperform the older aircraft and yet be less expensive to operate and support. While it is too early to make a final statement on the program's prospects for success, there are obviously major difficulties to surmount before the program's goals are achieved. These difficulties are discussed in detail in appendix I.

In conducting our review, we discussed the LHX program with officials of the LHX program office at the U.S. Army Aviation Systems Command, St. Louis, Missouri, and at the Army Aviation Center, Fort Rucker, Alabama. We also solicited the views of all the prime contractor teams participating in the program.

As agreed with your office, we did not obtain official agency comments on this report in order to expedite its issuance. We did, however, solicit the views of the Under Secretary of the Army and representatives from the Army's LHX program office. There was general agreement with the contents of the report, although some changes were suggested in the interest of accuracy. These have been made where appropriate. The Under Secretary reiterated the pressing need to replace the current light helicopter fleet because of obsolescence. He stated that while the LHX's goals were challenging, setting such goals was necessary to drive development efforts towards achieving substantial gains in capability, while controlling acquisition costs and lowering operation and support costs.

Issues Concerning the LHX Program

Introduction



The Army believes there is a critical need for a family of light, fast, highly maneuverable rotorcraft which will be survivable on the future battlefield. The Light Helicopter Family (LHX) will be designed to meet those needs and replace the aging fleet of light helicopters. The LHX is planned to address 36 of the 39 light fleet material deficiencies outlined in the Aviation Mission Area Analysis. Senior Army leaders maintain they are not committed to the LHX program until it is shown that the LHX can meet expectations. However, in other echelons within the Army, support for the program appears to be building.

The advantages offered by the LHX are numerous and attractive. According to the Army, existing light helicopters—the UH-1, the AH-1, the OH-58, and the OH-6—need replacement as they are getting too old to support and their performance falls short of what the Army sees as demanded by the modern battlefield. If the LHX program meets all its goals, it would offer a new fleet of light helicopters whose performance met the needs of the modern battlefield, whose operation and support costs would be nearly half those of the fleet being replaced, and whose average flyaway costs in 1984 dollars would be \$5.3 million per aircraft.¹

The Army has publicized the rationale for the LHX and has expounded on the program's virtues. This report does not try to revisit the program's justification in detail. Rather, it concentrates on factors essential to accomplishing LHX objectives, and discusses some of the concerns about accomplishing them. The following areas are covered: acquisition costs, affordability, operation and support (O&S) costs, performance requirements, technical risks, acquisition strategy, and alternatives. Because of the early stage of the program and its changing nature, the information in this report is likewise subject to change.

Acquisition Cost

Current Army estimates show that to develop and acquire over 5,000 LHX rotorcraft will cost \$38 billion in constant fiscal year 1984 dollars and \$61 billion in escalated dollars. A major portion of the cost relates to the sophisticated mission equipment package avionics. This package constitutes about 40 to 50 percent of LHX flyaway costs.

The Army cost estimates at this stage are still preliminary; there has been no official baseline cost estimate. Much of the mission equipment

¹Flyaway costs are a subset of procurement costs which exclude the cost of initial spares, repair parts, training support, support equipment, data, and site activation.

package estimate is based on engineering judgment and thus must be considered soft. Complicating the estimating process is the lack of cost experience on aircraft similar to the LHX. Also, no cost estimates have been made independent of the Army's Program Office. Recently, the Under Secretary of the Army stated he would order an independent cost estimate to be done.

The Army established unit flyaway cost goals for the LHX very early in the program. These goals are \$6 million for the Scout/Attack (SCAT) version and \$4 million for the utility version (in fiscal year 1984 dollars), or a fleet average of \$5.3 million. The Army has held fast to the unit cost goals, despite early indications that the goals could not be met without sacrificing capability. The Army has conducted several requirements scrubs, including deletion of substantial amounts of mission equipment from the utility version, to keep estimates within the cost goals. For example, the Army deleted requirements for helmet mounted displays and a night vision system from the utility version and will make provisions for adding them later.

If Army cost estimates prove to be optimistic or if cost growth occurs, the Army will not meet its cost goals. In addition, the Army estimates are based on production buys of 480 aircraft per year, which preliminary assessments indicate are not affordable. Lower production rates will increase unit costs.

Probably very few additional requirements can be scrubbed with the LHX still being able to accomplish its mission. Efforts to scrub acquisition costs and adhere to the unit cost goals could result in deleting aircraft equipment important to mission effectiveness. Senior Army officials said they would not permit mission effectiveness to be impaired even at the expense of increasing acquisition costs. Further cost scrubs could impair features designed to lower operation and support costs.

Additional program cost information is detailed below.

- Research and development cost estimates have remained fairly constant since the first estimates in 1983. The 1984 constant dollar estimate has remained at \$2.5 billion. The escalated research and development estimate rose from \$3.1 billion in 1983 to \$3.2 billion currently. The increase was due primarily to delays in starting full-scale development because funds obtained for the advanced rotorcraft technology integration (ARTI) program were less than expected.

- The procurement estimate decreased slightly in constant 1984 dollars, going from \$36.8 billion in 1983 to \$35.7 billion currently. The decrease was due to mission equipment scrubs, primarily on the utility version. Escalated costs decreased from \$79.9 billion in 1983 to \$57.4 billion currently. The decrease was due primarily to use of lower out-year inflation indexes (from 4.4 percent to 2.3 percent), more than offsetting some increased costs from stretching procurement because of full-scale development start delays.
- The first official estimate—the baseline cost estimate—is scheduled for early 1987 to coincide with the Milestone II Army Systems Acquisition Review Council/Defense Systems Acquisition Review Council (ASARC/DSARC) as required by Department of Defense regulations. Full-scale development will begin in October 1987. The Army is also developing cost estimates for the cost and operational effectiveness analysis being prepared for consideration at the upcoming ASARC/DSARC.
- The Program Office has made preliminary cost estimates for the SCAT version using production rates lower than 480 aircraft per year. At 480 aircraft per year, unit flyaway costs for the SCAT version in 1984 dollars are estimated at \$6.02 million per aircraft; at 360 per year, \$6.09 million per aircraft; at 240 per year, \$6.42 million per aircraft.
- Until tooling and facility commitments for a specified production rate are made, changes in the planned rate can be made without great cost penalties. Such changes become very expensive when production rates are less than the rate tools and facilities were designed for. Under these circumstances, cost increases could fall in the 10- to 15-percent range.
- If the production rate falls to 240 per year, the Army will consider selecting only one contractor for production, taking advantage of higher production rates while sacrificing potential benefits due to competition.
- The contractors emphasized that the Army expects them to make substantial investments in tooling out of their own funds without any assurance of winning a share of production. In addition to keeping tooling costs down, the Army believes reducing the amount of special-purpose tooling could enhance mobilization since this type of tooling requires a longer lead-time than general-purpose tooling.
- One contractor told us initial full-scale development funding was too low to meet the schedule. Low funding levels have already been a problem for the ARTI program. The Army believes the funding it has programmed for the LHX is all that can be used efficiently.
- The same contractor identified high cost risk items as the mission equipment package and the composite airframe. The contractor also said its mission equipment package cost estimate was rather soft and could vary as much as 25 percent either way.

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- Army unit cost estimates for the SCAT and utility versions in 1983 were \$6.5 million and \$5.5 million, respectively. Currently they are estimated at \$6 million and \$4 million, respectively, in line with Army goals. The decreased estimates resulted from Army decisions to delete or modify mission equipment from the LHX, especially for the utility version.
 - The Best Technical Approach was originally (in 1983) scheduled to be completed by December 1984.² By June 1985, scheduled completion had slipped to August 1985. The approach was finally published on March 31, 1986. Best Technical Approach slips have been caused by overall delays in the LHX program in addition to disagreements and indecision on the composition of the mission equipment package. Such uncertainty has made cost estimates difficult and changeable.
 - The required numbers of LHX, as well as the mix of SCAT and utility aircraft, to be procured are still in a state of flux. The total planned procurement and procurement mix have a large impact on acquisition cost estimates and may affect the current unit cost goals.

Affordability

The affordability of the LHX program depends on whether the Army will be able to provide the needed funding in the Aircraft Procurement, Army (APA) account throughout the program. According to preliminary Army assessments, the most difficult funding year the LHX will face is 1997, when LHX is in peak production. Projected available funding falls short of LHX requirements in 1997 and during several other peak production years.

Despite this assessment, the Army believes the LHX is affordable under the following conditions: a peak production rate somewhere between 240 and 360 aircraft per year, sustained real growth in the APA account over the next 12-15 years, completion of all current aircraft procurements except UH-60 by 1992, and no cost growth in the LHX program. One factor—real growth in the APA account—is not entirely within the Army's control. Successfully controlling the other factors will require great effort coupled with a top priority assigned to LHX. Despite these efforts, available funding still appears insufficient in the APA account, and the Army is considering lowering the extended buy of the UH-60, eliminating planned purchases of tilt rotor aircraft, and/or lowering requests for funds in other procurement accounts to make more funds available to APA. While hard choices such as these are being posited, a

²The Best Technical Approach is the result of several trade-off studies conducted on a weapon system, which include technical concepts, logistical support, costs, and schedules.

belief exists at lower echelons within the Army that sufficient funding will be available in the out years for LHX.

Additional affordability information is detailed below.

- Production rates of less than the currently planned 480 aircraft per year will increase estimated procurement unit costs.
- Projections for funds available to the LHX are less than what is currently estimated as needed, even with real growth in the APA account.
- Any large programs initiated in either APA or other procurement accounts are likely to cause competition with LHX for available funds.
- Projecting a 1 percent real growth and 3 percent inflationary growth in the APA account from the present would put the APA at about \$5.5 billion in the year 2000. Of that amount, an estimated \$2 billion will be needed for modifications and other items for existing aircraft, while the LHX will need the remaining \$3.5 billion. This leaves a shortage of funds for the UH-60 or tilt rotor unless funds are diverted from other procurement accounts.

Operation and Support Costs

A major goal of the LHX program is to field aircraft which, as a fleet, will cost 40 to 50 percent less to operate and support than the fleet they will replace. While the LHX is intended to replace AH-1, UH-1, OH-58, and OH-6 aircraft, the Army concedes that cost savings on the order of the goal will be achievable only as compared to the UH-1 and AH-1. Key drivers of the savings in O&S costs from a design standpoint are reliability, maintainability, single pilot cockpit, and commonality of the components of the two versions of the aircraft. Critical to these are the capacity and computational increases offered by electronics technologies—very high speed integrated circuits (VHSIC) in particular. Replacing old aircraft on a less than one for one basis is also an important factor in meeting the O&S cost goal. O&S cost guarantees are contained in the LHX engine contracts, and the Army hopes to do the same with the airframe contracts.

At this point, several factors cast doubt on the ultimate achievability of the LHX's O&S cost goals or on whether such savings will be quantifiable. Data concerning the O&S costs of the existing fleet are not readily available. Comparisons of the existing fleet with the LHX fleet are also sensitive to factors such as the number of hours each type of aircraft is flown, the ratio according to which the LHX will replace the older aircraft, and the different missions each type of aircraft can perform. Several projected O&S benefits are not directly controllable by the LHX.

program. Personnel reductions due to fewer pilots and less maintenance as well as the number of aircraft the LHX will replace are decisions to be made outside the LHX program. Also, actual O&S savings cannot be determined until data from operating LHX aircraft are available. In particular, tangible demonstrations of LHX reliability and maintainability—perhaps the greatest contributors to O&S reductions—will not be available until operational testing in 1993. Finally, while being cited as program goals, specific O&S cost reductions are not included in official requirements documents, raising the question of whether the goals will remain quantifiable over time.

Additional O&S cost information is detailed below.

- O&S costs are estimated at \$39.2 billion in constant fiscal year 1984 dollars over a 20-year period.
- LHX O&S cost saving features, such as fewer maintenance personnel, spares reductions, less scheduled maintenance, and two level maintenance, are basically results of reliability, maintainability, single-pilot cockpit, commonality, and less than one for one replacement.
- Reliability and maintainability appear to be the greatest contributors to O&S reductions, accounting for well over half the reductions by one estimate.
- Reliability gains will be attained through designing in reliability and through the reduced number of parts, an all-composite airframe, and a rotor system which is less complex than that of the system being replaced. Reliability will also be enhanced through capabilities offered by VHSIC technology. For example, VHSIC technology offers backup circuits to take over when others fail.
- Maintainability gains will derive primarily from designing line replaceable units to the module (circuit board) level versus the black box level, coupled with accurate built-in fault diagnosis to the module level. VHSIC also plays a significant role in these capabilities.
- Reliability and maintainability gains are design dependent and thus will require priority and resources during the design stages of development to eventually bring them to fruition.
- While the contractors agree that the single pilot cockpit will result in savings, one contractor estimates that it will account for 10 percent of O&S savings, while another estimates that the single pilot cockpit will save on the order of 25 percent of O&S costs.
- It is now generally agreed within the Army that even if the single pilot cockpit works out, the total number of Army pilots will not be reduced. According to the Army, without the single pilot LHX, increasing demands would necessitate an increase in the total number of pilots. If successful,

the single pilot LHX would also offer greater capability (flying more missions) with the same number of pilots.

- The LHX program will attempt to delete the intermediate level of maintenance required by current aircraft largely through eliminating the need for automatic test equipment at that level. Elimination of the test equipment depends on a lower spares volume resulting from reliability improvement, designing replaceable units to the module level, and having accurate built-in fault diagnosis to the module level.
- According to one contractor, LHX mission equipment reliability will have to improve 10-fold over current aircraft to achieve LHX mission reliability.

Performance Requirements

The LHX's design is intended to respond to requirements emanating from the AirLand Battle doctrine, threat projections, an analysis of mission profiles, and the single crew cockpit. The main driver appears to be employing our helicopters beyond the forward line of troops where they will face an advanced threat without the advantages of being in friendly territory and selecting battle positions from a defensive posture. This severe operating environment requires a level of sensor capability and automation beyond that of the Apache, currently the Army's most advanced attack helicopter. Analyses have shown that without higher performance sensors and avionics, the work load exacted by the proposed LHX employment scenarios exceeds acceptable limits for even a two-member crew.

Having a single crew cockpit necessitates a higher level of automation than does having a two-member crew, as there must be greater interaction between sensors and more highly automated flight controls to reduce the work load of the single crew member. However, it appears that the LHX's design risks and sophistication are more heavily influenced by the mission requirements than by going to a single-member crew.

Additional requirements information is detailed below.

- Under projected LHX employment scenarios, the SCAT can remain un concealed to the enemy for only 10 seconds, compared to 30 seconds for the Apache. This is not enough time for a person to manually search for targets; the search has to be automated.
- The 10-second limit may add support to the need for a single pilot cockpit as there may not be enough time to coordinate the actions of two crew members, according to the Army.

- The 10-second limit will necessitate engaging targets in two stages: rising from a concealed position to search for targets and store data, returning to a concealed position to select a target, and rising again to launch and guide its Hellfire missile. There is some question whether this scenario will allow enough time to guide the Hellfire to the target.
- Because of the longer time the Apache needs to acquire targets, it cannot function across the forward line of troops like the LHX.
- Threat weapons faced by the LHX will be improved over those faced by the Apache.
- The SCAT is the design driver; the utility will be derived from the SCAT.
- Within the Training and Doctrine Command there are some reservations regarding the feasibility of the single pilot cockpit from a pilot work load standpoint.
- The Army will consider deleting the heavier work load missions from the LHX to make the single-pilot crew acceptable. The Apache would then handle these missions.
- Several features critical to mission performance regardless of crew size are: digital map, automatic target acquisition, aircraft survivability and target acquisition sensors, and voice-activated controls.
- Several features critical to having a single crew are automated flight controls, automatic navigation update, automatic target recognition, aircraft survivability equipment display integration, and wide field-of-view helmet-mounted display.
- An effort is under way to further reduce costs and weight through mission equipment reductions, which will result in another requirements revision.

Technical Risks

The LHX will incorporate many state-of-the art technologies which are new to Army aviation. Some of these include a composite airframe, VHSIC, fly-by-wire flight control systems, voice-activated controls, and automatic target recognizers. The ARTI program and other advanced development efforts are under way to assess and reduce LHX technology risks, as well as to determine the feasibility of the single-pilot SCAT.

The Army and contractors are in general agreement that the riskiest technology areas are VHSIC, the electro-optic target acquisition and designation system, and the wide field-of-view helmet-mounted display. All agree that risk reduction efforts must be undertaken, including building early models of this equipment, before start of full-scale development. Failure of the Army to provide funding for risk reduction efforts in fiscal year 1987 could further delay the start of full-scale

development and could lead to unacceptable technical risks being carried into full-scale development. Such risks generally translate into increased costs and schedule delays.

Additional technology risk information is detailed below.

- The Army plans to spend \$33 million in fiscal year 1987 on efforts to reduce risk in the high technology risk areas prior to full-scale development in fiscal year 1988.
- Full-scale development schedule slips, though costly, may allow for state-of-the-art technologies to advance to greater maturity for incorporation in the LHX.
- Software and integration of the mission equipment package may be riskier than the individual components themselves.
- There seems to be general agreement that the T-800 engine is relatively low risk.
- It may be difficult to meet the 8,500-pound weight goal, especially, as one contractor pointed out, in combination with stringent unit cost and O&S cost goals.
- One contractor believed the composite airframe was a significant risk. Producibility has not yet been demonstrated, and there are potential problems with assessments of damage to composites in field use.
- One contractor believed there had not been enough preliminary design effort under the ARTI program. All contractors advocated additional risk reduction efforts after ARTI, as the Army is now planning.
- One contractor noted that VHSIC production yields were still unsatisfactory. According to the LHX Program Office, VHSIC yields may not be a problem by the time the LHX enters production. Success of the mission equipment package is highly dependent on VHSIC.
- The VHSIC technology has definite risks, as the first few prototype chips are just now emerging from DOD's phase I VHSIC program. The LHX's development cost and schedule are predicated on using VHSIC chips developed under this program, rather than relying on development of custom chips for the LHX.
- Senior Army management views VHSIC as more of a management risk than a technical risk. According to Army management, if the technology does not work out, very large scale integrated circuits can be substituted without increasing aircraft weight.

Acquisition Strategy

The Army developed the LHX acquisition strategy to maximize competition during both development and production. The Army is carrying two contractor teams through preliminary flight rating on the engine and

critical design review on airframe development. The goal is to select one team for the rest of development and then split this team for competition in production.

The acquisition strategy for the LHX represents something new for the Army. Encouraging teaming and competition may lead to substantial long-term benefits but involves some short-term risks, or trade-offs. One such trade-off is that this approach leads to additional costs during development. If the program continues, the extra costs should be recouped through lower production costs resulting from greater production competition. The extra costs of teaming arrangements have already led to a change in the acquisition strategy. The Army had originally planned to carry two teams in airframe development through the end of full-scale development but later decided to down-select to one contractor team earlier—at critical design review—to save nearly \$1 billion in development costs. Early experience with the engine contracts and teaming arrangements seems favorable, which could bode well for the airframe development as well.

Engine full-scale development began in July 1985 with contract award to two contractor teams. Airframe development is now scheduled to begin in October 1987 after a recent 6-month delay due to ARTI funding difficulties. An ASARC/DSARC is now scheduled for early 1987; LHX production will begin in January 1994. The first LHX unit should be equipped by May 1996.

Additional acquisition strategy information is detailed below.

- Some contractors believe the current strategy, with single team selection at critical design review, will encourage contractors to postpone investments in tooling, facilities, etc., as long as possible. One contractor believes the Army should select a single team at the beginning of full-scale development to preclude that possibility. (The Army acquisition strategy requires contractors to make substantial corporate investments without assurance of any payback by receiving a production contract).
- One or more of the airframe contractors could back out of the competition due to the heavy requirements for corporate investment, which would be a major blow to the Army's competition strategy.
- A potential back-up acquisition strategy is to pursue the LHX utility version initially and delay the SCAT to await further maturity in technical risk areas. Senior Army management is opposed to this approach, stating it would take pressure off of solving the tough design problems

of the SCAT, could jeopardize commonality, and could subject the SCAT to a new set of requirements downstream.

- Engine contractor teams, in a competitive environment, have signed up to stringent design-to-cost and O&S cost contractual guarantees. The Army hopes to do the same with the airframe contracts.
- Engine contractors characterize the Army schedule for engine development as aggressive but doable.
- Some concerns have been expressed by one contractor and by a Department of Defense official that the development and test program is too heavily oriented towards airframe, powertrain, and target acquisition concerns, while not giving enough attention to avionics architecture, particularly automated sensor integration.

LHX Alternatives

The Army plans to develop a new aircraft for LHX missions, though alternatives are available and have been studied to some extent. The Army is conducting a cost and operational effectiveness analysis to compare the LHX against three alternatives: (1) the existing light fleet upgraded with safety and reliability and maintainability product improvements, (2) the current heavy fleet (Apache, Blackhawk, OH-58D) with safety and reliability and maintainability product improvements plus capability enhancements (this alternative also includes procurement of some commercial light utility helicopters with minimal militarization), and (3) an LHX tilt-rotor with SCAT and utility versions.

The Army's early alternatives study, conducted at the request of the Senate Armed Services Committee, concludes that procuring additional heavy fleet aircraft is the least costly alternative in terms of total investment costs. The Army argues, however, that lower O&S costs for LHX will offset, over the long run, the somewhat higher acquisition costs.

The alternative of improving the existing light fleet is probably not viable. These aircraft are already in some cases 20 to 30 years old and cannot handle many additional improvements. In addition, their O&S costs are likely to increase with age. Alternative 2 involves buying more of our most modern helicopters, taking advantage of larger production runs and additional fleet commonality. Lower acquisition costs for this alternative may, however, be offset by the higher O&S costs and costs for buying more replacement aircraft than would be necessary in the LHX program. However, the numbers of LHX needed to replace the current aircraft will not be known until after completion of the cost and operational effectiveness analysis. Also, though the Army projects up to 50

percent O&S cost savings for the LHX, such projections cannot be proven out until years of field experience are gained.

The Army cites the following reasons for preferring LHX over alternatives with lower acquisition costs:

- The projected O&S savings with the LHX will more than offset higher acquisition costs.
- A new aircraft can incorporate survivability measures which current aircraft cannot.
- The LHX can incorporate modern technology and thereby greatly increase its capabilities over those of current aircraft, which are designed primarily with 1970 technology.
- The Army believes that without the single-pilot LHX SCAT, there will not be enough pilots for the greater number of two-pilot Apaches needed.
- With LHX, because of its greater capabilities, the Army believes it can accomplish required missions with fewer aircraft than would be needed if it bought larger quantities of existing heavy aircraft.
- One contractor pointed out that using the Apache, larger and more expensive than the LHX, amounted to "overkill."
- Clearly, although the cost and operational effectiveness analysis is not completed, the Army believes the LHX is more effective than other alternatives, and less expensive on a life cycle cost basis.

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